SIEMENS

PATENT
Attorney Docket No. 2003P15291US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Inventor:	V. Philip et al.	)		
		)	Group Art Unit:	1762
Serial No.:	10/733,740	)		
		)	Examiner:	K. Bareford
Filed:	December 11, 2003	)		

Title: REPAIR OF ZIRCONIA-BASED THERMAL BARRIER COATINGS

Commissioner For Patents
PO BOX 1450
Alexandria, VA. 222313-1450

Sir:

APPELLANTS BRIEF

This Appeal Brief relates to an appeal from the final rejection of claims 1-23, 25 and 26 in the Office Action mailed February 28, 2006.

Real Party in Interest

This application is assigned to Siemens Power Generation, Inc. (f/k/a Siemens Westinghouse Power Corporation), a Delaware corporation having a principle place of business in Orlando, Florida. Siemens Power Generation, Inc, is a wholly owned subsidiary of Siemens Corporation of Iselin, New Jersey.

Related Appeals and Interferences

There are no prior and pending appeals, interferences or judicial proceedings known to Applicants, Applicants' legal representative, or Assignee which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

Status of Claims

Claims 1-23, 25 and 26 stand finally rejected by the Office Action mailed February 28, 2006 and are presently under appeal in this proceeding. No other claims stand rejected, allowed, withdrawn, objected to, or canceled.

Status of Amendments

An amendment after final rejection was filed on April 7, 2006. The amendment after final sought to place the claims in better condition for appeal by overcoming the Section 103 rejections to the independent claims via incorporating dependent claims and previously presented claim limitations that were not rejected under Sections 103. However, the Examiner refused to enter the amendment. Therefore, in addition to the focal Section 112 rejection, this appeal concerns the outstanding Section 103 rejections.

Summary of Claimed Subject Matter

Independent Claim 1

Referring to Figures 1 and 2, independent claim 1 recites a method of applying a zirconia-based porous thermal barrier coating 24 comprising:

selecting a composite powder 12 comprising an unbound homogeneous mixture of a first constituent 14 comprising stabilized zirconia particles and a second constituent 16 comprising particles of a ceramic material having a melting temperature sufficiently low so that the second constituent particles at least partially melt when applied with a low velocity oxygen fuel process; (page 4 lines 1-16) and

using the low velocity oxygen fuel process to apply the composite powder 12 and apply the porous thermal barrier coating 24 to a surface. (page 4 lines 22-30, page 5 lines 5-21)

<u>Independent Claim 5</u>

A method of applying a zirconia-based thermal barrier coating, the method comprising:

selecting a composite powder 12 comprising a first constituent 14 comprising zirconia particles and a second constituent 16 comprising particles of a ceramic material having a melting temperature sufficiently low so that the second constituent 16 particles at least partially melt when applied with a low velocity oxygen fuel process (page 4 lines 1-16) ; and

using the low velocity oxygen fuel process to apply the composite powder 12 to a surface; (page 4 lines 22-30, page 5 lines 5-21)

further comprising applying the composite powder 12 to the surface of a component 22 without removing the component from a machine of which it forms a part. (page 5 lines 5-21)

<u>Independent Claim 13</u>

A method of repairing a zirconia-based thermal barrier coating, the method comprising:

selecting a composite powder 12 comprising a first constituent 14 comprising zirconia particles and a second constituent 16 comprising particles of a ceramic material having a melting temperature sufficiently low so that the second constituent 16 particles at least partially melt when applied with a low velocity oxygen fuel process; (page 4 lines 1-16)

providing access to a damaged region of a zirconia-based coating on a component 22 of a machine; (page 4 lines 22-30)

cleaning the damaged region; (page 4 lines 22-30) and

using the low velocity oxygen fuel process to apply the composite powder to the damaged region without removing the component 22 from the machine. (page 4 lines 22-30, page 5 lines 5-21)

Dependent Claim 23

The method of claim 1, wherein the thermal barrier coating has a void percentage in the range of 20-25%. (page 5 lines 19-21)

Dependent Claim 25

The method of claim 5, wherein the composite powder comprises an unbound homogeneous mixture. (page 4 lines 7-9, page 5 lines 17-21)

Dependent Claim 26

The method of claim 13, wherein the composite powder comprises an unbound homogeneous mixture. (page 4 lines 7-9, page 5 lines 17-21)

Grounds for Rejection to be Reviewed

Whether independent claim 1 and dependent claims 25 and 26 are unpatentable under 35 U.S.C. § 112 first paragraph, as failing to comply with the written description requirement for containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors had possession of the claimed invention at the time the application was filed.

Whether independent claims 5 and 13 are unpatentable under Section 103(a) as being obvious over Longo '184 (USPN 4,450,184) in view of Nagaraj (USPAP 2005/0191516).

Whether independent claims 5 and 13 are upatentable under Section 103(a) as being obvious over Longo '343 (USPN 3,607,343) in view of Nagari (USPAP 2005/0191516).

Appellants' Argument

A. Applicants Invention

Thermal barrier coatings, such as yttria-stabilized zirconia, are commonly used to protect underlying substrate components from high temperature environments. Page 1 lines 8-9. However, these coatings can become damaged and require repair. One repair approach is to transport the damaged components to a repair facility equipped to make such repairs. Another repair approach is to locally repair the damaged component in order to save transportation and other costs. Also, locally repairing the damaged component without removing the component from its larger assembly can lead to further cost savings. The invention is particularly applicable to in-situ field repair of turbine hot gas path components having a zirconia thermal barrier coating.

Prior art methods for the in-situ field repair of such thermal barrier coatings include plasma spray, low velocity oxygen fuel (LVOF) spraying, and ceramic paste techniques. Page 1 lines 21-31, page 4 lines 17-22. Plasma spraying is problematic for in-situ field repair operations because the extremely high temperatures and particle velocities associated with plasma spraying creates problems with nearby components. LVOF is problematic because the low spray temperature does not allow the ceramic thermal barrier coating material to properly adhere to the component. Ceramic paste is problematic because the relatively weak resultant chemical bond associated with ceramic pastes similarly does not allow the ceramic thermal barrier to properly adhere to the component. Applicants' invention improves in-situ field repair of thermal barrier coatings.

Applicants invented a thermal barrier coating formed from a composite powder comprising two constituents: (1) a first constituent comprising a relatively high melting temperature ceramic powder 14 that normally cannot be successfully applied with LVOH, and (2) a second constituent comprising lower melting temperature powder 16 that normally can be successfully applied with LVOF. Page 4 lines 1-7, page 5 lines 5-8. The two constituents are mixed together to form a homogenous mixture prior to spraying, such as by ball mixing or by wet chemical mixing. Page 4 lines 7-16. The two constituents are then sprayed onto the

damaged component via a LVOF process. Page 4 lines 17-30. When the composite powder is applied the damaged component, the lower melting temperature constituent 16 is at least partially melted by the LVOF process and resolidifies to form splats 26 that surround and encase the unmelted or potentially partially melted particles of the high melting temperature material 14. Page 5 lines 9-17. The two constituent particles 14, 16 can sinter during a subsequent high temperature heat treatment and/or during the subsequent operation of the component to provide a relatively porous in-situ locally repaired thermal barrier coating. Page 5 lines 17-21. Of course, the inventive spray process can be used in connection with applications other than in-situ field repair of turbine hot gas path components.

B. <u>Section 112 rejection of claims 1-4, 6-12, 22, 23, 25 and 26</u>

The Examiner states that claims 1-4, 6-12, 22, 23, 25 and 26 are unpatentable under 35 U.S.C. § 112 first paragraph, as failing to comply with the written description requirement for containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventors had possession of the claimed invention at the time the application was filed.

Claims 1, 25 and 26 recite that the composite powder comprises an <u>unbound</u> homogenous mixture of a first constituent and a second constituent. The Examiner contends that using the term "unbound" to modify the phrase "homogenous mixture" is new matter. To support this contention, the Examiner cites Webster's dictionary to interpret 'unbound' to mean "not held in chemical or physical combination" (and Applicants agree with such interpretation). The Examiner then states "the constituents must be in at least physical combination."

In the amendment after final (not entered by the Examiner), Applicants respectfully submitted that the Examiner misapplied her own interpretation of the term 'unbound' by reading out the word '<u>held</u>'. That is, the term 'unbound' does not mean that the constituents are not in physical combination (in fact, the powder constituents are in physical combination - i.e. mixed). Rather, the term 'unbound' means that the constituents are not <u>held</u> in physical combination.

In the Advisory Action, the Examiner responded that "at the very least the formed physical mixture would be 'held' in that homogenous state prior to spraying of the composite powder." Applicants respectfully submit that the Examiner is again misapplying her own interpretation of the term "unbound".

The term "unbound" requires more than the constituents being in physical combination, and further requires that that the constituents are not 'held' or positively linked together (whether chemically or physically). For example, simple table salt (sodium chloride) is held or positively linked by chemically binding the constituent sodium and chlorine atoms together. For another example, a simple bound notebook is held or positively linked by physically binding the constituent paper sheets with spiral wire or glue.

Applicants respectfully submit that the specification suitably conveys that the inventors had possession of the modifying term 'unbound'. Page 4, lines 7-9 explains: "The two constituents are mixed together to form a homogenous mixture prior to spraying, such as by ball mixing or by wet chemical mixing. Those skilled in the art would readily understand that the inventors had possession of the knowledge that the powder constituents can be unbound since ball mixing and wet chemical mixing produces a powder whose constituents are unbound. Moreover, the specification discloses that, after mixing, when the composite powder is sprayed, the lower melting temperature constituent 16 is at least partially melted by the spray process and resolidifies to form splats 26 that surround and encase the particles of the high melting temperature material 14. Page 5 lines 9-17. Thus, Applicants unquestionably appreciated that the LVOF process binds the mixed powder into positively linked constituents. The deliberate and intelligent choice to bind the constituents by the LVOF process, in of itself, evidences that Applicants appreciated that the constituents are unbound prior to the LVOF process. To require Applicants to have explicitly disclosed a negative (i.e. that the mixed constituents are unbound prior to being bound by the LVOF process), as the Examiner seems to be requiring, is well above the written description requirements of Section 112 and therefore impermissible.

Reversal of the Section 112 rejection is therefore respectfully requested.

C. First Section 103(a) rejection of claims 5 and 13

The Examiner states that independent claims 5 and 13 are unpatentable under 35 U.S.C. § 103(a) as being obvious over Longo '184 in view of Nagaraj.

Claims 5 and 13 recite selecting a composite powder comprising a mixture of a first constituent comprising stabilized zirconia particles and a second constituent comprising ceramic particles having a melting temperature sufficiently low so as to at least partially melt when applied with a LVOF process. The claims further recite using the LVOF process the apply the composite powder.

Longo '184 teaches an improved abradable coating. Col. 1 lines 6-9. Longo '184 addresses the prior art problem of abradable coatings that have weak bond strengths and are friable, as well as have relatively low temperature resistance. Col. Col. 2 lines 8-26. In particluar, Longo '184 discloses that its inventive ceramic powder comprises hollow sphere particles that are made by fusing the particle constituents into a partially or fully homogenized hollow structure. See e.g. col. 3 lines 56-59, col. 2 lines 53-55. Longo '184 further explains that its fused hollow sphere powders are advantageous over non hollow sphere powders in achieving the aims of the invention. See e.g. col. 4 lines 43-60. Longo '184 further discloses that its inventive ceramic powder that may comprise one or more laundry list of constituents, some of which meet Applicants' first constituent claim limitation and some which meet Applicants' second constituent claim limitation. Col. 3 lines 7-19.

The Examiner argues that constituents that meet the limitations of Applicants' claimed first and second constituents can be found within the laundry list of powder constituents disclosed by Longo '184. The Examiner contends that it would be obvious to selectively pick and chose from among Longo's laundry list the constituents "with an expectation of desirable coating results, as the selection of such materials is taught by Longo '184" Final Office Action page 6 para 10. Applicants respectfully disagree that Longo '184 teaches selecting a first constituent comprising stabilized zirconia particles and selecting a second constituent comprising ceramic particles having a melting temperature sufficiently low so as to at least partially melt

when applied with a LVOF process. Rather, Applicants respectfully submit that <u>Longo '184 teaches selecting one or more constituents that provide an abradable coating having strong bond strengths and are friable, as well as have relatively high temperature resistance</u>. Col. 4 lines 43-60, Col. 2 lines 8-26. Selecting a constituent having a melting temperature sufficiently low so as to at least partially melt when applied with a LVOF process would not provide the relatively high temperature resistance that Longo '184 seeks. Thus, Longo '184 teaches away from Applicants claimed invention.

In addition to the above patentable distinction, the Examiner admits that while Longo '184 does not teach using a LVOF process to melt the first and second constituents and that the machine is repaired in-situ, but argues that Nagaraj teaches these limitations and that it would have been obvious to one skilled in the art to modify Longo '184 in such a manner. In particular, the Examiner contends that it would have been obvious to use flame spraying as well as plasma spraying because while Nagaraj teaches plasma spraying, Longo '184 teaches either flame or plasma spraying. Applicants respectfully submit that one skilled in the art faced with the in-situ repair problem that Applicants solved would have used the Nagaraj high temperature plasma spraying method because Nagaraj's spray process is specifically intended for in-situ repairs whereas the Longo '184 teaching is not intended for in-situ repairs.

Reversal of the Section 103(a) rejection is therefore respectfully requested.

D. <u>Second Section 103(a) rejection of claims 5 and 13</u>

The Examiner states that independent claims 5 and 13 are unpatentable under 35 U.S.C. § 103(a) as being obvious over Longo '343 in view of Nagaraj.

Claims 5 and 13 recite <u>using the LVOF process the apply the composite powder</u>. As explained in Applicants' specification, the high temperature, high particle velocity, and/or high sound energy levels of prior art plasma spray processes, render them unsuitable for Applicants' claimed invention. See e.g. spec. page 4 lines 18-2, page 2 lines 16-20.

Longo '343 (filed approximately 15 years before Longo '184) teaches a <u>nonporous</u> flame sprayed coating. Col. 1 lines 6-9. Longo '343 addresses the prior art problem that although

flame sprayed coatings are generally porous, there is a need for a nonporous flame sprayed coating. Col. 1 lines 14-40. Longo's inventive aspect involves bonding a fluxing ceramic, such as titanium dioxide, to the surface of the flame sprayed powder. Col. 2 lines 6-67. Longo '343 emphasizes that its coating intentionally provides a "substantial reduction in porosity" and may be considered "self-sealed" and "impermeable". Col. 3 lines 29-37.

Longo '343 discloses a <u>conventional high temperature high velocity spray process</u>. In particular, Longo '343 explains in column 1 lines 35-40 that the process can use either a plasma-type gun or the power-type gun described in USPN 2,961,335, which, in turn, teaches in column 2 lines 5-6 that the gun is useful for "materials of extremely high melting points" such as zirconia, and further teaches in column 3 lines 29-39 that the gun provides the "conventional high forward linear velocity component" which "may be as high as the speed of sound". Applicants parenthetically note that column 4 lines 15-26 of Longo '343 discusses the temperature of the substrate, not the temperature of the spray.

Applicants respectfully incorporate their earlier argument regarding the Examiner's improper combining of Longo '184 and Nagaraj to read on Applicants claimed in-situ repaired coating by using a LVOF process.

Moreover, dependent claim 23 recites that the thermal barrier coating is porous, having a void percentage in the range of 20-25%. In contrast Longo '343 emphasizes that its coating intentionally provides a "substantial reduction in porosity" and may be considered "self-sealed" and "impermeable". Col. 3 lines 29-37.

Reversal of the Section 103(a) rejection is therefore respectfully requested.

E. <u>Rejection of Dependent Claims 25 and 26</u>

Dependent claims 25 and 26 depend from independent claims 5 and 13 respectively. The Examiner has not rejected claims 25 or 26 under Section 103, but rather only under Section 112. Claims 25 and 26 recite that the powder is unbound.

F. Conclusion

For the foregoing reasons, Applicants respectfully submit that the rejections set forth in the final Office Action are inapplicable to the pending claims. The honorable Board is therefore respectfully requested to reverse the final rejection of the Examiner and to remand the application to the Examiner with instructions to allows the pending claims. Please grant any extensions of time required to enter this paper. Please charge any appropriate fees due in connection with this paper or credit any overpayments to Deposit Account No. 19-2179.

Respectfully submitted,

Dated: 5/26/06

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Claims Appendix

1. (previously presented) A method of applying a zirconia-based porous thermal barrier coating, the method comprising:

selecting a composite powder comprising an unbound homogeneous mixture of a first constituent comprising stabilized zirconia particles and a second constituent comprising particles of a ceramic material having a melting temperature sufficiently low so that the second constituent particles at least partially melt when applied with a low velocity oxygen fuel process; and

using the low velocity oxygen fuel process to apply the composite powder and apply the porous thermal barrier coating to a surface.

2. (original) The method of claim 1, further comprising selecting the second constituent to comprise particles of calcium titanate.

3. (original) The method of claim 1, further comprising selecting the second constituent to comprise particles of strontium titanate.

4. (original) The method of claim 1, further comprising selecting the second constituent to comprise particles of sodium-zirconium-phosphate-silicate.

5. (previously presented) A method of applying a zirconia-based thermal barrier coating, the method comprising:

selecting a composite powder comprising a first constituent comprising zirconia particles and a second constituent comprising particles of a ceramic material having a melting temperature sufficiently low so that the second constituent particles at least partially melt when applied with a low velocity oxygen fuel process; and

using the low velocity oxygen fuel process to apply the composite powder to a surface;

further comprising applying the composite powder to the surface of a component without removing the component from a machine of which it forms a part.

6. (original) The method of claim 1, further comprising selecting the second constituent to comprise at least 20% by volume of the composite powder.

7. (original) The method of claim 6, further comprising selecting the second constituent to comprise from 20-40% by volume of the composite powder.

8. (original) The method of claim 1, further comprising selecting the second constituent to comprise a material exhibiting a coefficient of thermal expansion within 30% of that of the first constituent.

9. (original) The method of claim 1, further comprising selecting the second constituent particles to comprise a material exhibiting a coefficient of thermal expansion within 20% of that of the first constituent particles.

10. (original) The method of claim 1, further comprising selecting the second constituent particles to comprise a material exhibiting a coefficient of thermal expansion within 10% of that of the first constituent particles.

11. (original) The method of claim 1, further comprising selecting the second constituent particles to comprise a material exhibiting a thermal conductivity of no more than 20% higher than that of the first constituent particles.

12. (original) The method of claim 1, further comprising selecting the second constituent particles to comprise a material exhibiting a thermal conductivity of less than that of the first constituent particles.

13. (original) A method of repairing a zirconia-based thermal barrier coating, the method comprising:

selecting a composite powder comprising a first constituent comprising zirconia particles and a second constituent comprising particles of a ceramic material having a melting temperature sufficiently low so that the second constituent particles at least partially melt when applied with a low velocity oxygen fuel process;

providing access to a damaged region of a zirconia-based coating on a component of a machine;

cleaning the damaged region; and

using the low velocity oxygen fuel process to apply the composite powder to the damaged region without removing the component from the machine.

14. (original) The method of claim 13, further comprising selecting the second constituent to comprise particles of calcium titanate.

15. (original) The method of claim 13, further comprising selecting the second constituent to comprise particles of strontium titanate.

16. (original) The method of claim 13, further comprising selecting the second constituent to comprise particles of sodium-zirconium-phosphate-silicate.

17. (original) The method of claim 13, further comprising selecting the second constituent to comprise a material exhibiting a coefficient of thermal expansion within 30% of that of the first constituent.

18. (original) The method of claim 13, further comprising selecting the second constituent particles to comprise a material exhibiting a coefficient of thermal expansion within 20% of that of the first constituent particles.

19. (original) The method of claim 13, further comprising selecting the second constituent particles to comprise a material exhibiting a coefficient of thermal expansion within 10% of that of the first constituent particles.

20. (original) The method of claim 13, further comprising selecting the second constituent particles to comprise a material exhibiting a thermal conductivity of no more than 20% higher than that of the first constituent particles.

21. (original) The method of claim 13, further comprising selecting the second constituent particles to comprise a material exhibiting a thermal conductivity of less than that of the first constituent particles.

22. (previously presented) The method of claim 1, wherein the composite powder is applied to the surface of a component without removing the component from a machine.

23. (previously presented) The method of claim 1, wherein the thermal barrier coating has a void percentage in the range of 20-25%.

24. (canceled)

25. (previously presented) The method of claim 5, wherein the composite powder comprises an unbound homogeneous mixture.

26. (previously presented) The method of claim 13, wherein the composite powder comprises an unbound homogeneous mixture.

Evidence Appendix

None